

Fig. 3, 3a, 3b, *D.*—*n. sp.*—Nongsingriang.

„ 4, 4a, 4b, *D. oligopleuris*, W. Blanf. n. sp.—Teria Ghat.

„ 5, 5a, animal of *D. folliculus*, Pfr. Deyra Doon variety.

Pl. IV. Burmese species.

Fig. 1, 1a, *D. sperata*, W. Blanford, Arakan Hills, west of Prome.

„ 2, 2a, *D. Puppensis*, W. Blanford, Puppa Hill, Upper Burma.

„ 3, 3a, *D. exilis*, W. Blanford, Mya Leit Doung, near Ava.

„ 4, 4a, *D. nana*, W. Blanford, Akoutoung, Pegu.

(For descriptions of new species, see last paper.)

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*Notes on the PANGONG LAKE district of LADAKH, from journal made in 1863.—By Captain H. H. GODWIN-AUSTEN, F. R. G. S., Topographical Surveyor.*

[Received 16th June, 1866.]

To the north of the Indus, from its junction with the Dras river, lies a high range of mountains which separate the Indus drainage from that of the Shayok or Núbra river. The axis and great mass of this range is granitic; on the west this extends to within a very short distance of the river, while at Pitùk below Leh, the granite hill on which that large and well-known monastery stands abuts on the Indus itself, and thence towards the east for a considerable distance it holds the same position. The great mass of coarse sandstones, red clays, grits, and conglomerates seen on the right bank of the Indus, west of Pitùk, are now seen on the left or south bank, thence to the east in the direction of Stock and Himis. On the above granite range are several passes leading into the Shayok valley, all of great elevation, and on the direct road from Leh to the Pangong lake are two, viz., the “Chang La,” and the “Kay La,” both high, being respectively 17,470 and 18,250 feet above the level of the sea.

The ascent to the first is gradual from the village of Tagar in the Chimray valley, which there divides into two large ravines,

the western branch leading to the Wuri La, while the eastern runs up to the two passes above-mentioned. On the 15th July, when our party crossed the Chang La, the snow that had fallen in the early part of the month still lay covering about three miles of the road, and being fresh, it was glaringly white in the sun and much affected the eyes of our servants and the coolies, while all suffered more or less from the effects of the rarified air; curious to say, on the return journey *viá* the Kay La, 800 feet higher, scarcely a man suffered from this cause; we had then been living for some time at a high altitude, which very probably had not a little to say to our immunity from the fatigue and headache engendered at high elevations. The mountains on the northern side are perfectly bare, a little grass growing only along the bottom of the valley which had a steady easy slope the whole way to Durgo; a small tarn lies near the encamping ground below the pass, and another somewhat larger is passed about a mile further down the valley, and the scenery is not remarkable save for its huge scale and bleakness. Before reaching the village of Durgo, one emerges out of the narrow valley upon the level surface of one of those large accumulations of alluvial sands and shingles that are seen along the large valleys of these mountains; the powerful force that accumulated the materials that form them is now extinct, and the circumstances attending their formation, and more wonderful subsequent denudation, are as yet but little understood. At this spot the vast scouring process was well exemplified, the level of the plateau on which I stood could be traced across the valley in and out of its numerous ravines in a perfectly horizontal line of a different colour, where very small portions of the alluvium still adhered to the slopes and precipices; and I do not think I am exaggerating when I state that its thickness at the junction of the streams below Durgo was over 1,500 to 2,000 feet. Traversing the level surface of this plateau for about a mile its edge is reached, and Durgo with the valley up to Tanksè is then clearly seen, a narrow green belt near the river with barren easy slopes thence to the foot of the hills.

The whole valley is very open,—low cliffs of alluvial sands and clays can be traced the whole distance on both sides,—and it is self-evident that at no very distant period this presented a long reach of water. An after sojourn on the Pangong fully confirmed this; it was in fact

a drained portion of that line of lake; perhaps caused by some local alteration in the levels of the country.

From Dürgo to Tanksè is a distance of eight miles and the road quite level. The stream is considerable and contains a small kind of fish of which I saw numbers at the Dürgo bridge. The road follows the right bank for nearly the whole distance, mountains rise to a great height on either side, and at the southern end of the valley, towering above Tanksé, is the fine snowy peak called in the survey Tanksè No. 1. The village of this name is large and a very fair area is under cultivation—lucerne grass grows luxuriously. Many of the houses are built close under a large mass of conglomerate, the stones firmly cemented in it, and to this cause it must owe its present existence at the mouth of the narrow gorge towards the Pangong, out of which the soft beds have been washed away. The remains of an old fortified post still cover the upper portion of this conglomerate bed. The main stream comes from the southward, and drains the Lúng Yùghma valley and the mountains on the north of the Indus river. It is joined at Tanksè by the small stream that drains the valley up which the road to the Pangong runs; this is at first rather shut in and confined by the mountains that rise in cliffs on either hand, but where it takes the more direct easterly direction it opens out considerably; high cliffs of the alluvial shingly deposits again occur, forming a belt at foot of the mountains of the northern side about 300 feet high and some 400 yards distant from the stream. Mùglib, where I halted, about 11 miles from Tanksè, is a very small place. At this point a broad belt of green pasture land extends along the valley, and through it the little clear stream finds its way in a very tortuous course, but above Mùglib this green belt becomes very swampy and on it several Brahmini ducks were seen. The stream above flowed over a stony debris from the hills, with occasional patches of grassy and watery ground, and at about three miles the road passes two little tarns; these had been evidently larger at that season of the year when the snows are melting, or after an extra amount of rain has fallen. The physical appearance of the whole length of this valley showed unmistakable signs of its having at one period been the bed of a lake, and I am induced to think for a portion of that time continuous with the portion below Tanksè and that the mass of alluvial above Dürgo

was contemporary with that above Mùglib. Above the two lakes, Tragùmè Bur Tso, there is no longer any water in the bed of the stream save at intervals here and there, where it breaks out in a small rill to lose itself in the loose gravel a few yards lower down. Over distances of more than a mile it is deep white sand, the collection of which is a good deal due to the wind. Down to this sand the talus from the mountains extends tending every year to increase the height of level. At the low pass of Surtokh, whence one obtains the first view of the Pangong lake, this action is nowhere so well seen; this ridge of Surtokh forms the watershed across the natural exit for the waters of the great lake and is entirely formed by the loose shingle brought down a somewhat large lateral ravine from the snowy peaks to the south: this bed of talus actually divides, part to the eastward, part to the west, as exemplified in the sketch annexed (Fig. 1), so that the waters may in some years flow one way, in others another. If the supply of water to the Pangong lake were equal to what it must formerly have been when the glaciers were double their present size, the continual flow of water would soon carry off these talus accumulations from the mountains above Surtokh; there being now no force in action for this purpose, the snows of winter and the waters of the side ravines tend to raise the main valley level every year. The Pangong Tso (lake) is about two and a half miles distant from the low ridge of the Surtokh La, or more properly speaking, its natural bar or bund, but the level of the old lake bed extends up to within a very short distance of the pass. A rise of 150 feet in the waters of the present lake would find them again an exit down the valley to Tanksè. A Trigonometrical station lies close to the water's edge, it bears east-south-east from a rock, a quarter mile distant out in the lake, and is marked with a stone having the usual dot and circle cut on it; its height has been determined trigonometrically to be 13,931 feet above the sea. From this mark-stone, a fine view of the first long reach of this elevated and interesting piece of water is obtained. Its colour is of an intense blue, the water as clear as crystal, but far too saline to be drinkable; there was quite a true salt water feel in the air as the wind blew off it. This was a good site from which to form a commencement of my survey work, as knobs and peaks were seen for many a mile along the spurs that descended from





the ranges bounding the northern shores. From the height at which one stood these all appeared comparatively low; only on the highest lay a few small patches of snow, thence to their bases was one succession of shades of yellows, purples, reds and browns, the invariable colouring of Tibet—not a scrap of green. My intention was to proceed along the northern shore as far as it was possible, and eventually to turn north, and work round into Chang Chùngmo. But it being necessary first to see something of the south side also, I left the supplies and sepoys at the spot where we had first struck the lake; and taking one small tent, I marched on, skirting the southern shore towards a low point that runs down to and overlooks the whole of the western end, and forms the termination of the longest spur from the lofty snow-bound range, which forms the southern watershed of this basin.

Late in the afternoon we reached a very small patch of cultivation, with some two or three wretched huts called Spang Mik, and the next morning, by 9 A. M., reached the foot of the low point, named by the Survey Pankong (*b*) Hill Station. For so high an elevation, a considerable amount of green grass, Tibetan furze, and cultivation occurs on the west side of the hill, having a few houses scattered about it, forming the village of "Mun," the largest in the Pangong district. I ascended from it to the station by a short easy pull of some 1,000 feet above the lake, obtaining a most commanding view, up and down it, across to the spurs of north bank and high up among the snowy peaks to the south, where small glaciers just show their noses above the masses of the old moraines, which extend down to the ancient level of the lake. Little streams flow down these steep inclines like silver threads from the ends of these glaciers, to finally lose themselves in the silt and sands that skirt the edge of the lake, for only the most considerable of these streams find an exit in its waters. Such is the one that flows through the little oasis of Mun; it owes its size to the streams from three glaciers uniting some distance above the village. The silt brought down by these, has formed a miniature delta, or arm of shallow water, running out into the lake. In the course of a conversation with the coolies and men of Mun, I learnt that some three or four marches further on, the lake narrowed to a mere stream which was fordable, and that it was not necessary to follow the northern shore, where ran besides the worst road. I

changed my route, sent back for the supplies and camp at Spang Mik, and late in the evening, they had all arrived. Other advantages accrued by following the south shore, *viz.*, that I saw more of my ground without having to ascend to very high peaks, there was plenty of water and wood as far as the Chushal river, and the villages extended further. On the other hand, the northern shore is very bare, and water is only obtainable by digging holes close to the edge of the lake, into these water percolates, but only slightly less saline. On the 22nd July, my march lay over the sandy, stony plain, skirting the shore of the Pangong, crossing two or three ravines, where sections are well displayed of former and higher levels of its waters in sands, interstratified with an angular rubble like that distributed over the present surface. At about eight miles from Mun, the straggling village of Mèruk is passed on the right hand, and the last on the lake Karkpèt is three miles further. The level ground between the shores and the foot of the mountains increases much in breadth as one proceeds east, and the stream from Chushal gives, from a distance, no signs of its proximity, and I was rather surprised on coming suddenly upon a fine body of water, flowing with a quiet current through a narrow belt of green grass some 10 feet below the surface of the plain. Finding plenty of wood and a nice green sheltered spot under the bank, I pitched camp by the side of it.

The extent of level ground here is considerable, quite ten square miles, dotted over in the vicinity of the stream with a few low bushes, and over the rest grows a scanty coarse grass in tufts. Towards the shore of the lake rise two very conspicuous isolated low rocky knobs a mile apart, and between these is the confluence of the Chushal stream and the Pangong Tso. The next morning I walked across and ascended the most eastern eminence, having the strange sounding name of Tuggù Nuggù. This had formerly been a fortified post, the level space at the top was enclosed by a low stone wall, while a detached out-work had been built on the low spur that ran out on the east side; none of my coolies, who were all from this district of Pangong, could give any account of it, as to when or by whom it had been built; it must be comparatively an ancient work, still considering how soon events are forgotten by such men, its age may be only 150 to 200 years. It was a lowering morning; and before I had finished



my survey work from this position, it came on to rain hard, which we sat out on the top; the shower passed off up the lake, and it had a fine effect on the view in that direction, with the lines of falling rain over the expanse of water, and the misty mountains bounding its sides. The state of the plain which, when dry, is covered with a hard incrustation of lime and a salt, that crackles under the feet, had now by the wet been turned into a sticky loam that adhered to the boots in huge lumps, and remained like a cement upon every thing it came in contact with. One and a half miles beyond Tuggü Nuggü low spurs abut upon the lake in cliffs of 150 to 200 feet high, and the way leads along the narrow shore at their foot, with very deep water washing the bank. Passing one large bay we rounded a low narrow point of beach only to find the existence of another bay, called Phürsook: this forms the boundary between the Kashmir Rajah's territory and the Chinese district of Rudokh. Phürsook formed a circular sheltered little lake in itself, a narrow strait only connects it with the water outside. It was evidently of great depth in places where the hills came down in cliffs upon it, a narrow beach ran along the foot of these formed of talus cemented by lime. The bay formed a perfect harbour, in which a line of battle-ship might have floated, and sailed in and out of. Were this lake in a less elevated region, or on a line of trade, how useful would the water communication prove up and down the extent of its two long portions. The first or lower lake is 40 miles in length; the second 33, giving a total of 73 miles, exclusive of the upper long portion beyond Tso Nyak, which is quite 18 miles.

I shall not detail each day's march, winding in and out of the bays of this long length of water, but will attempt to give a general description of it, connected with which are several points, both curious and interesting.

The first that must strike any one of observation is the evidence of this lake having been formerly fresh for its entire length. Myriads of dead fresh-water shells now strew the shore: these, thrown up by the waves in a long white ridge, lie so thick in some of the bays they can be taken up in handfuls. They are principally of *Lymnæa* and *Planorbis*; but though I searched diligently, I never found a large bivalve, only one very tiny *Pisidium* that I found inside one of the



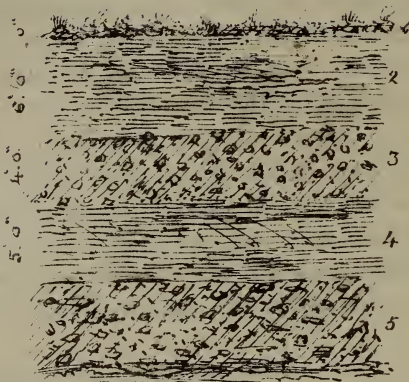
specimens of *Lymnæa*; nor did I ever find a living specimen, which I had hoped to do in the upper lakes, where the water was very slightly brackish. When these shells existed, the former lake must have had quite a different aspect from its present one, and in it must have grown for the sustenance of these molluscs beds of water plants, while its banks would have been fringed probably with grass and rushes. In the lower lake there is not a vestige of any sort or kind of plant, the beautifully blue clear water washes a bank of sand and pebbles, the latter perfectly free even of algæ. This is not the case beyond Ote, where the water is much less salt, there the stones under water are extremely slippery and covered with vegetable growth. At this part also, patches of a coarse water weed are also seen here and there along the shore, but not growing luxuriantly, and evidently making a struggle for existence. The waters of the western end are far more salt than those of that near Ote, noticeable even to the taste, but it is not until the stream that connects the two portions is fairly entered that it is by any means drinkable; thence for the whole distance eastward, we used the lake waters save when we had the luck to find a spring of really fresh. By looking out carefully, we discovered springs in three places flowing out from under the bank; and in one spot, these springs were bubbling up for some distance out into the lake, rendering the water quite fresh around. It was quite a pleasure to see the poor yâks who carried our baggage take their fill of it, when for three days they had drank nothing but salt water. A curious feature of the Pangong is the almost entire absence of streams, whose waters find an exit in it, considering the great area that some of them drain; for, with the exception of the few glacial rills and the Chushal stream on its south shore, and the stream at the extreme west end, from the Marse Mik La, there are none. The northern shore is particularly dry, not a single rill joins it for its entire distance, until arriving at "Pal," on the upper lake; and the same may be said of the southern shore, from the Chushal river to Ote, and for many miles beyond. Many of the ravines have their sources at a considerable distance, but near the lake have broad dry beds from 2 to 3, and up to 500 yards in breadth of rubble and sands. I may instance the very large lateral ravine at Ote, the longest branch of which runs back into the snowy mountains of Chang Chûngmo, for

a distance of 40 miles, draining altogether an area of nearly 400 square miles. The silt which in former times has been carried down from the above area has formed the plain of Ote, the broad barrier to what would otherwise be a continuous long reach of water. This was no doubt the old configuration of the lake, for a rise of some 12 feet would cover the greater part of the Ote plain even now. In nearly all the higher ravines, water is plentiful, and glaciers of the second order are seen, but the streams are all sopped up in the broad bed of the main valley which acts like a perfect sponge; the stream breaks out occasionally here and there only to hide itself a few hundred yards down, the last water seen being above the fort of "Lanakh-khur," but it nowhere is seen to flow into the lake, being lost in the sands of the plain.

Another point in the history of this lake, on which may be based a good deal of theory as to its older aspect, is the former size and extent of its waters. On every side unmistakeable traces that the level was much above the present one, are seen in the lines of old beaches and in the beds of sand, containing the fossil remains of fresh-water shells,\* interstratified with beds of angular debris, which I mentioned before, are to be seen in the little dry ravines that cut through the plain, over which the road from Mun to the Chushal stream runs. Fig. 2. is a rough section of these beds, in which No. 1 represents the present plain of surface debris, the scattered talus of rocks brought down from the mountains of the south bank, when the small glaciers, at present only two to four miles long, extended nearly down to the lake, as proved by their old moraines still to be seen. Winter snow and the water action of time have spread their materials far out, nearly down to the water's edge. No. 2 are fine sands and arenaceous clay, such as would be now in the process of formation near the débouchement of the Chushal stream, perhaps a little coarser, which a moister climate would entail. It contains shells and stems of plants. No. 3 is a bed of angular debris, the same in every respect as the upper bed, No 1, but much thicker. No. 4 again are sands, like No. 2, containing the same shells. No. 5, debris as beds 1 and 3.

\* These fresh-water shells are the same as those now found on the edge of the lake, while the stems of plants are plainly discerned; where these last are seen, the sandy clay is generally tinged with an iron colour.

Fig. 2.



This section proves great changes, and also, I think, that the lake existed prior to, certainly during the latter part of, the great glacial period in the Himalayas. Whether the scooping out of the depression in which its waters lie, is due to glacial action in the first instance, when this high region was (as is most probable) deeply overlaid by ice and snow, is a hazardous question, and one rather problematical. From the alternation of the beds of *débris* and finer deposits, we can infer that there have been changes from milder and moister seasons than at present exist, back to colder and drier; during the first, beds like No. 3 would have been deposited by the increased transporting power that would have carried the materials further out into the lake; while, at the same time, the level of the waters would naturally have been much higher. Its waters must then have generally held much silt and mud in suspension to form the shell beds of above section. At the present day, no deposit of any kind is taking place, save perhaps near the debouchements of the Chushal, and the extreme western tributaries. A closer inspection with some levelling would, I think, somewhat clear up the mystery attached to the huge masses of alluvial deposits seen in the valleys of all the great rivers of the western Himalayas, from the Chang Chúnghmo and Leh, to Skardo in the valley of Kurgyl and valley of Dras, and on both the Jhelum



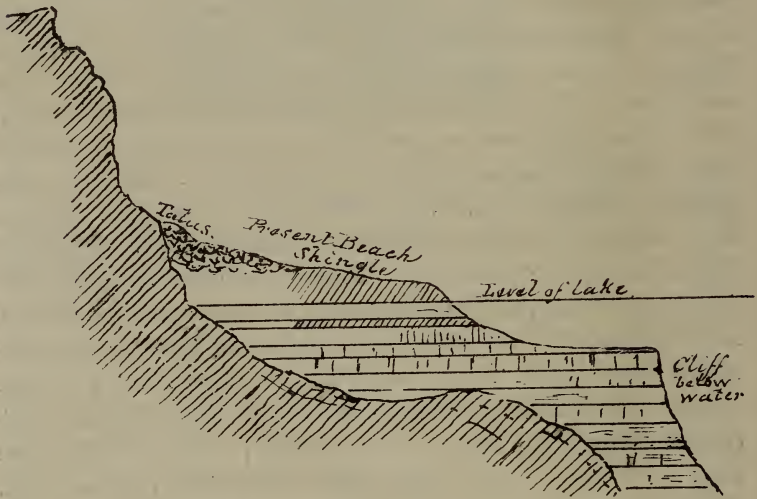
and Chandra-bagha (Chenab) rivers. Give a greater rain-fall to the Pangong district, and a lower snow line (now above 20,000 feet), the ravines would be seen with fine running streams in them, and, allowing time, would cut through the barrier at the Surtokh La;\* and eventually down through the whole length of the alluvial deposits in this lake basin, the large valley and its tributaries then drained would resemble most closely on either side the sand, shingle, and conglomerate deposits now seen at Tanksè and on the above-named rivers. These deposits at Ote would be somewhat higher, and would cover a greater area from the junction of the great tributary there. The height of the waters of the Pangong have much diminished, and are diminishing at the present day: the first travellers who visited it, now some years ago, would I think find a marked difference on its shores. The coolies of the district assured me that formerly, say 30 years ago, it was not practicable to proceed along the southern shore, following close to the edge of the lake from Phürsook to Ote, which at present is quite easy—even yâks can be taken. Only in one or two spots was there any difficulty, where the cliffs approached close down to the water's edge. A rise of 15 feet would bring the water close to them, and even 10 feet would render such places quite impracticable for animals and nearly so for man. From other information I could collect, the fall must now be from 1 to  $1\frac{1}{2}$  feet per annum. The difficult spots mentioned above have only been practicable for yâks for the last four years (1863); before that time the track lay over a rough ridge a short distance back from the shore. The men of the district also said that it is only for the last 20 years or so, that the waters have fallen at this rapid rate. The rock that lies out in the lake at its western end, distant  $1\frac{1}{4}$  mile from the shore, is about 5 feet high. It has only been noticed for the past four years, so this would again give a fall of about one foot a year. Again the numerous lines of the beach marks,—and at some points as many as five and six can be counted,—denote falls of level of about a foot.

\* The rock bounding the north side of this pass is a hard crystalline limestone, nearly on edge, up to the plane surface of which the ridge of detritus extends. The depth to which the rocks *in situ* have been eroded prior to the talus that has since been precipitated against them, is in all probability sufficient to drain the whole extent of the Pangong and valley towards Tanksè, if these present accumulations were removed.



These all lying close to the water's edge are very recent, as evidenced by being so well defined. But as a proof that the waters of the Pangong lake in former times have fallen below its present level, I may state that on a long point of land in the little bay of Phürsook in deep very clear water, I looked down upon a terrace 10 feet below the surface which terminated in a cliff, where the stratification of the sand and clays could be well seen, the bottom was not visible beyond this, and it was too far out to sound the depth. This would be the section,

Fig. 3.



The only deduction to make from such comparatively recent changes is, that the level of its waters has been alternating with moist and dry periods of time, the slow process of which may be even now going on almost imperceptible to man: the water of the Pangong depending as it does mainly on the winter snow, (query, may not the snow-fall in this part of the Himalayas be much less now than formerly?) and the country passing through a period of diminishing falls. Slow as such changes may be, they are by no means improbable or impossible. The western end of the Pangong Tso lies as nearly as possible in latitude  $34^{\circ}$  and longitude  $78^{\circ} 30'$ , thence its direction is due south-east to latitude  $34^{\circ} 40'$ , it then takes a bend easterly

and follows that latitude as far as Noh, in longitude  $79^{\circ} 50'$ . The mountains to the north-west of the first long reach are of no great apparent elevation; in July there was very little snow to be seen, and only on the very highest portion, or the main range, which nevertheless is from 18,000 to 19,500 feet high; the highest peaks being 20,000; but the level of the lake being 13,931 feet above the sea, detracts considerably from their great altitude. The terminal knobs of the spurs from the above range lie close on the edge of the lake, rising to the height of 600 to 1,500 feet, generally terminating precipitously, and the lake I should imagine is excessively deep at such places. It would be a most interesting scientific enquiry to sound with some portable kind of boat the depth of this lake. To the south-west a high range runs parallel to the lake, some of the peaks on which attain an altitude of 21,500 feet; this range terminates in a peak above and to the east-south-east of Tanksè, which is 20,003. The above fine line of mountains, covered as they are with perpetual snow, and their ravines terminating above in small glaciers, form a fine boundary to this valley on the south. The southern watershed follows the lake very closely as far as Ote. It there extends further south, and between that place and Pal, several very large lateral ravines descend into it, all with the usual broad, dry, gravelly beds, the largest of these are the Algrong, Tengun, Kiam-Surpo Loombas, or valleys. On the northern shore, beyond the very large valley of Chang Burmah, which finds its exit at the Ote plain, there is another, the Dal-Loomba, that drains the considerable tract of 150 square miles; the silt carried down from this has narrowed the lake very much, forming a low point jutting out into it, and has contracted the waters to a quarter of a mile in breadth. Altogether the mean breadth of the second lake, "Tso Nyak," or "middle lake" is much less than the first or true "Pangong."

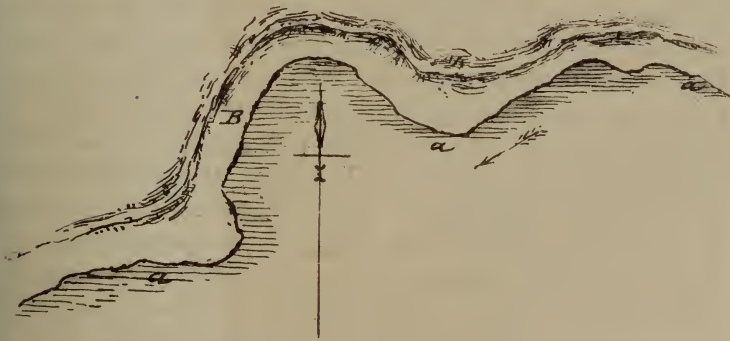
Wherever a tributary ravine joins the shore, there is grass, scanty as a rule, and of a very coarse kind. At Ote it is much richer, especially in the vicinity of the stream that unites the two lakes. On both banks of the second lake, wood is found in plenty, growing luxuriantly in places; at Algrong and Numkum it formed a scrubby jungle, but on the northern shore, at Silùng, it was met with no more, and the only fuel was a stunted plant which throws out a good

deal of woody root, and is found all over this country; and I never found a scarcity of it even up to 18,000 feet in the Chang Chùngmo, save where the ravines were very rocky. Descending from the small ridge between Paljùng and Pal, the extensive plain near the latter comes in view, bounded by low spurs on every side save the east, where a conspicuous peak rears its head. A small stream winds its way through the eastern side of the "maidan," and joins the lake being the only one on the northern shore that does so. Three and a half miles beyond Pal, the second lake ends, and a small stream is found flowing into it through half a mile of sandy flat ground, beyond which is another lake, called Tso Rum, having a length of about four miles. After crossing again some flat ground, Lake Tso Nyak, (the second,) is reached connected as before described with Tso Rum below. Near the northern shore of this last is situated the small village of Noh, a short distance up a tributary from the north. This place I much wished to visit, but as will be shown further on, I could not manage to accomplish it. On the northern shore of Tso Nyak, the effects of a very peculiar natural force may be seen; at intervals a ridge of sand and earth runs parallel to the line of beach, at first I attributed this to the action of waves, but observing the large proportions of these banks in some situations, and at last seeing the ridge quite 6 feet high; and, moreover, that the bank had been fairly turned up, as if with a gigantic plough, I was fairly puzzled to account for such an appearance, and on questioning the guides then learnt, that during winter, when the lake is frozen over hard, the water naturally accumulates under the ice and flowing westward can find no exit. When the pressure becomes too great it tears up the frozen earth on the shore and being liberated flows over the surface of the ice. I give a slight sketch (Fig. 4.) of a section through one of these banks, showing the old surface grass still growing on the perpendicular face of the upheaved ground, which of course is on the inland side. On measuring this, I found it an inch or two over 6 feet.

Fig. 4.



I noticed also that the banks were higher and better developed on the western curves of the bays. One reason for this may be seen by a glance at the accompanying diagram, (Fig. 5.) where *a, a, a*,  
 Fig. 5.



represent the shore of the lake, the waters of which have a tendency to flow west, in direction of the arrows. These waters (?) suddenly increased by springs in bed of lake, and subjected to the upper pressure of a frozen surface meet with another resisting force in the curve of the bay at B. That line where the ice, united to the frozen ground, meets the dry soil into which water does not percolate, and is consequently comparatively dry, would be the



line of least resistance; and upon that line the disruption would take place and the pent up waters find an exit. Where the bank is sandy or clayey and covered with grass, it would be turned up in the manner as shown in Fig. 4. In spots where the shore is gravelly, the water seems to drive in the sand and stones before it from the bottom of the lake out upon the shore, and this being a continuous annual action it has in some bays formed a bank quite 3 feet high. Whether this phenomenon has been observed before on other lakes I do not know; it could not take place even here, did not this lake Pangong receive a large amount of water from the east, with a determination to flow towards its old natural exit near Lũkoong. During summer, evaporation no doubt carries off a great amount of the surplus water that drains into it, but in the winter this must cease, and with its upper casing of ice the water to free itself thus tears and roots up the bank in the curious manner above detailed.

During the whole time I spent on the shores of the Pangong, the only animal I saw was the Kyang, or wild ass of Tibet, a few couple of these were grazing on the grassy maidans of the northern shore. Of the birds, geese were plentiful in the stream between the first and second lakes, and I saw many young broods. The Brahmini goose, teal, a red-headed diver with white body, and a very black plumaged duck, made up the water birds. There was a great scarcity of the smaller birds, a sandpiper and wagtail were occasionally seen on the shore. The large fish-eagle was plentiful at Ote, attracted there by the fish which are seen for the first time in the slightly brackish water flowing out of the upper lake; this lake is full of them, they much resemble the tench in shape and colour, only somewhat longer in the body, and are covered with slime like those fish. I had fortunately brought a rod, and all its et-cæteras, and had near Numkum, in deep water under the rocks, a very good afternoon's sport, catching some five and twenty; they ran about a pound in weight, the largest I caught being about 4 lbs. They would rise at a fly when the surface was much rippled, and seeing them rising at gnats, I managed to catch two with a small midge fly, the first artificial I fancy ever thrown on these waters; but their extreme clearness is much against fly-fishing. The most paying bait after all was dough; this they took readily enough, and I might have

caught double the number in another hour, but had to move on to camp. These fish formed a welcome addition to our food as long as we remained on the lake, I supplied my old Bhut Moonshie and some of the guard with hooks and lines, they became fierce fishermen, and brought in good bags. It is a fine sight to see the lake during a storm, when a good strong wind is blowing down a long extent of its surface, and dashing the waves, which rise to a considerable height, against the hard rocky shore: I had the fortune to see its surface in this state one morning, and sitting down watched the waves rolling in; it was a miniature sea, and Pangong waves brought up thoughts of beaches in old England. Though the country is so barren, the lake has its beauties in the varied tints of surrounding hills and mountains, and the rich deep blue of its waters, becoming quite of an emerald green colour as they shallow near the shore. During the summer months the lake is quite deserted, and we did not fall in with a soul the whole distance up to Pal, or we might not have got so far. At that time of the year, the flocks of shawl-wool goats, sheep and yâks, are grazed in the higher valleys on the young rich grass that springs up in some places after the snow has left the ground. During winter they are brought down to the level "maidans" near the lake, and Ote, I was told, becomes dotted with black "Champa"\* encampments. Snow, they said, never lies long at Ote, though the lake freezes all over very thick, and the degree of cold must be very considerable;—what a glorious expanse for skating the lake must then present! The Champas or Changpas, who spend the winter on the lake at Ote, come from both Noh and Rudok. The said plain is a disputed piece of ground; the men of the Pangong district claim it, though judging by the site of an old fort standing on a low rock on the north-western side of the plain, I should say it undoubtedly belongs to the Lhassan authorities, by whom it was built years ago: proximity of Leh and greater power of the Thanadar there, places it in the Kashmir Rajah's territory. Walls of stone and earth are built up as a portection for the tents against the wind; and to render them still snugger, I observed that the interior floor had been dug down to a depth of 3 feet, which must make them warmer abodes. I found the summer winds of this country cold

\* "Champa," the nomadic trides of this country.

enough, what the winter are like I can well imagine: the amount of comfort, in a tent on the edge of a frozen sheet of water stretching for miles, must be a very minus quantity. During the whole period of my sojourn there in August 1863, the weather, with a few solitary fine days, was miserably cold, nothing but cloud, sleet, and rain. I may have seen it under disadvantageous circumstances, and I trust at times it does enjoy a little warmth and brightness.

On the 1st of August we reached Paljung, and in the afternoon of that day came in sight of the first natives we had seen, viz., three men driving some yâks in our direction, they saw us at the same time, and turned and bolted; we followed, but failed to overtake them,—it being about two miles to the point they had rounded,—they had disappeared up some lateral ravine out of sight: our approach was, therefore, known to the Rudok men. It rained in torrents during the night, camp was pitched at Paljung, where a long broad nulla bed came down to the lake, and a low long promontory ran from the hills on the north out into it. Our road next day on towards Pal lay over this, it being a very long round to follow the shore under the cliffs. From the low pass the broad dull green plain of Pal was seen, and on its eastern side we discovered the black tents of a small Tartar camp. As our approach was now certainly known to these people, we bent our steps towards them. Three men came out to meet us, and turned out very mild individuals, one being a Lhama or priest. Their dogs, of the large Tibetan breed, were much more noisy and furious at the intrusion of strangers, and were not to be reconciled until long after the tents were up. These Champahs informed me that one of their number was about to ride into Noh at once to give the news of our arrival, and have it thence sent on to Rudok, I at once sat my Bhut Moonshi down to write a letter to the Governor of the place, requesting that he would raise no difficulty to my paying the place a visit, and see its monasteries, &c.

The next two days I remained at Pal, for the hills were buried in dense cloud and a good deal of rain fell, so that I was unable to proceed with any survey work in an eastern direction; on the third day, the Zimskang of Rudok rode in with some twenty followers, and pitched his tents on the other bank of the little stream, and came over at once to see me. He was a native of Lhassa, a short, stout, jovial



fellow, and brought a letter from the Governor of Rudok, and a white scarf, together with a present of two damuns (bricks) of tea, and some sheep and goats for my men. The letter was then read by the Moonshie, and was to the effect that it was not in his power to give me leave to visit Rudok, as he had strict orders from his superiors in Lhasa to prevent foreigners crossing the frontier, and that it would eventually be known if he permitted it. He added that he could not use force to prevent my further progress, but he trusted I would not lose him his appointment by so doing, and that I would accept the presents as a sign of friendship. Having received orders not to bring on any collision with the Chinese officials, I had to give up the idea of seeing Rudok, but I held out for one more march towards the place and gained my point, but not before showing some anger at their absurd wishes. The Zimskang again came over after my dinner about 9 o'clock at night, to beg I would not proceed any further; but I said they must abide by their first agreement. The afternoon of that day I was enabled to ascend the limestone mountain east of camp and fix my true position, the range around Rudok and the eastern end of lake were also again visible, and I was enabled to get intersections with other rays. The 5th broke fortunately clear and bright, so I started early along the shore of the lake in direction of Noh, my friend the Zimskang, stuck to me like a leech the whole day with a few of his men, and a curiously dressed rabble they were, with their enormous flat mushroom-shaped hats, and all mounted on little scraggy but sturdy ponies, they were all very jolly and amiable, I made no secret of my work, and showed and explained the map of the lake to him, which he thoroughly understood. I have found the people of Tibet far in advance of Hindustan as regards drawings, and what they are intended to represent. At a small hill called Tobo Nokpo, whence I had promised to return the previous day, I fulfilled my agreement evidently to the great pleasure of the Zimskang, who was now more pleasant than ever and thanked me with many salaams. On the 6th August my tents were struck to leave Pal, and the Rudok men did the same, I was invited over to their tents, previous to starting, to partake of a parting cup of salted tea churned with butter, which is always kept simmering on the fire; it is by no means a bad beverage



when made with good fresh butter. I gave him a few presents and we parted.

At the eastern end of the Pangong the hills somewhat decrease in altitude, the highest lying to the north of Noh. Looking in a direction due east from the higher points I ascended, the country appeared flat but undulating, and I observed in the far distance two or three pieces of water, these may turn out to be connected with Pangong Tso, probably bounded by steep sides which were not discernable at twenty miles, they may extend for some distance; the breadth of this high region was considerable, and extended up to a snowy range that rose suddenly on the south. The more level surface was not bounded by any mountains, and was seen stretching to the horizon.

The morning we left Pal was raw, cold, and cloudy; the road lay north-westerly for some distance over the dead level plain, that showed distinctly it had once been covered by water, for dead fresh-water shells are seen for some way; we then rose from it over a long very gradual slope of some three miles which at last contracted into a ravine, bounded with very low and easy scarped hills. A portion of this ravine was well wooded with the same kind of shrub as grew along the shores of the Pangong. The little camp of Champas continued their march with us; and had we been one day later coming into Pal, we should have missed them altogether and gone straight into Noh without meeting a soul. Nearly all their worldly goods were carried on sheep, only a few articles on the ponies which they rode. The women drove the former, and, in fact, did more in the packing, unpacking, and pitching of the tents, than their lords and masters; after which they were sent out on the hill side to collect the roots of a low shrub having a scent like lavender. One of the girls was very nice looking, and wore a peculiar head-dress which is not seen on the Ladakh side. The usually narrow fillet of cloth worn by the Ladaki women was treble the usual width, and covered with torquoise and silver ornaments; near the attachment at the forehead was a bar of silver set with small torquoise, pendant from which so as to lay on the forehead were a number of silver coins attached by short strings of coral beads, the effect was very good. I had the young lady brought over to my tent, where she sat for her portrait, and was delighted at the drawing made of her. The encamping ground was called Tobo

Rubern, and was a level piece of green grass, with several good streams of water flowing across it, for curious enough the higher ravines of the country have plenty of water, but they are all absorbed a few miles down in the sand and gravel of the broad water ways. The valley was here high, broad, and nearly level, the mountains were of no great elevation above it, not more than 3,000 feet; the lower slopes falling gradually from them into the valley, which was patched with furze of stunted growth, and plenty of good grass. The morning of the 7th broke clear, sunny, and bright, with a fresh breeze, we started early and gradually ascended the valley to the pass in our front, called the Dingo La (16,270 feet). On the top the ground was nearly level, expanding into wide open ground to the north; on the left rose a hill about 1,000 feet, which I determined to ascend to obtain a view over the hills and country around. Walking a short distance up this, a small tarn was seen in the centre of the level ground north of the pass, which had once evidently extended over the greater part of its area. Scattered plants of rhubarb are here seen but very tough and acid. The rocks were all of limestone formation, with a strike nearly east and west. I found no fossils, but it resembled in appearance the palæozoic rocks of Dras, &c. I obtained from the peak a fine view, but could see no more of the eastern end of the Pangong near Noh, on account of a dense haze in that direction. I was much disappointed and could only fix a peak or two looming up through the mist. My own camp and the Tartars had gone on, and I quickly followed them down the valley. This was very characteristic of these regions, spreading out into a broad gravelly plain, on the left side of which was a sharply defined scarp showing its general level had been uniform; this plain forms the head of one of the branches of the Dal Loomba. We parted with our Champa friends at a place called Chuchan, where they encamped to graze their goats and sheep for a few days, while we proceeded on along the side of the hills of the right bank rising gradually to a low pass called Sa Lam, and descending on the other side to another broad tributary of the Dal Loomba, which at this spot branched into three broad arms that penetrated into the mountains on the north for some eight miles. The longest of these valleys had a direction north-west, and up this our road to the Chang Chüngmo ran; no water was here to be found, and it was not until we

had proceeded another two miles that water was found in the bed of the ravine. Where we halted fuel grew in plenty—the yellow flowered Tibetan furze, differing slightly from the European in not being quite so thorny. The valley was still broad, but the hill sides descended into it with steeper slope, it was here called Drukker. When on the Sa Lam a horseman was seen riding down the valley from the north, who joined us. He had come from an encampment up the valley, and said he was sent to escort us on to the pass ahead. Our movements were, therefore, well known, though we should not have supposed a human being to have been within miles, but the Champas were evidently on the watch, and espied us the moment we topped the pass of Sa Lam. Between camp and the Demjor La, the valley bore the same character, save that the broad gravelly bed was covered with a luxuriant growth of furze, this swarmed with hares, which got up in all directions, and I had some good shooting. The Demjor La was reached about 10 o'clock, I found it by boiling point thermometer to be 17,465. The rise was gentle the whole way, and it fell in like manner into the valley on the north. As I came up to the usual pile of stones on the crest, two fine *Ovis ammon* came round a spur to the right, at about 200 yards distance. I managed to get a little nearer, but missed them. A fine mass of hill rose to the south appearing easy and near, I sent the camp on to the stream below and commenced its ascent. This was a good deal steeper and further than I had anticipated, proving to be 20,240 feet high, but the labour was rewarded, for from the summit I obtained a splendid view, and did a large amount of work; massive snow beds still covered the top, and the wind was bitterly cold. The mountains to the south of the Pangong were well seen, with the great snowy range near the Indus beyond Rudok; and I still longed to go on in that direction. Of the mountains to the south and west, there was a fine view of a country bleak, naked, stony, and inhospitable; only in a tributary of the great Chang Burma Loomba, whence was a way to Ote, was anything green, a little grass and furze there skirted the stream. Work being finished, we were soon down again upon the level ground of the valley; and on a piece of very wet ground, I was surprised to flush a snipe. It was a bitter cold evening, but the camp was in as sheltered a spot as we could find, and there was some good grass here for the yâks. Our Champa guide



took leave of us on the Dinjor La, so that we proceeded on the next day alone. The valley below camp took the usual configuration and ran towards the north-west, with a bed about one fourth of a mile broad. At about three miles we reached the confluence of a large valley from the north, and up this I determined to proceed, and thence ascend to Kiepsang, trigonometrical station. Several Kiangs were here seen, and up the valley numerous Tibetan antelope. After marching up the gravelly wide bed for five miles, whose main tributary turned to the east, and ended in an extensive elevated plain on the surface of which lay some large snow beds, we were rather at a loss to find water. I took the eastern branch, while the yâks and servants proceeded up the western (the Nertsè Loomba), towards a patch of green grass where I thought water would be found, and this proved to be the case. From this the staff on the top of Kiepsang was visible, and a very delightful little pull-up it looked. I followed the eastern branch to a low pass, which overlooked a narrow gorge that terminated a short way down on another high level plain. There was no track of any kind to be seen here, and my guides told me that the country on beyond was grazed over by a nomad tribe, called Kirghis, who did not own allegiance to the Rudok authorities; that they were great thieves and robbers, and occasionally came into Tanksè to exchange their wool for grain, of which they had none. These are the people who wander over the plains, thence to Ilchi and into a *terra incognita* on the east. It was not until late that I got back to camp, going to bed with the prospect of a stiff ascent next day. I was up and off very early, taking some breakfast with me; at this hour it was very cold, and the water of the little stream was frozen hard, and the backs of the yâks were quite white with frost. I took the line of a ravine which led up to the ridge east of the Kiepsang staff, the ascent was most fatiguing, over the loose angular débris that filled the steep bed of this ravine, whose waters were frozen into water-falls of ice. In this ravine we put up from under a rock a hare so benumbed with cold, it could not run, and it was knocked over with a stick by one of my coolies, to his great delight. On reaching the ridge, there was still a long pull up to the pole, but the view recompensed all the labor to legs and lungs; the ascent was 3,200 feet, the peak being 20,035, while the camp below was about 16,800. Bleak wastes of hill and wide dry drainage



courses met the eye to the north-east, backed by some high mountains, whose loftier peaks were covered with snow, and threw down some small glaciers. To the south the great tributary of the Pangong, the Mipal valley could be followed for many miles, high rugged angular mountains bounding it on every side. It was very, very cold, and I could scarcely do my work, or hold the pencil, the clouds were gathering up fast; and before I left the peak it had begun to sleet, I got under the lee of the ridge for breakfast and made a brew of tea in the boiling point thermometer pot, of which I gave a tot all round to the Bhuts, and then descended on the western side into the valley below; by skirting the hill sides down into the ravines and over spurs, we reached by evening the Kiung Gang La, 17,259 feet, on the boundary of the Kashmir and Rudok territory. At this pass are stationed throughout the summer months a guard of a few Rudok men,—these we now met,—and who got a dose of chaff from my Tanksé coolies, for thus being taken in rear, but they were very good humoured, and said that they were now off for their homes, and left that day with their ponies, black tent, tea churn, &c. We saw a good many antelope during the day. Near the pass was a great thickness of the conglomerates, sandstones, and coarse shales, seen in the Indus valley, which formation it is most curious to find having so wide an extension in this direction. This opens out a wide field for geological speculation. The south-west wind was bitterly cold all the afternoon, and in the tents, though they were in a somewhat sheltered ravine, it was very cold all night. The next morning we proceeded down the ravine to the north, which was grassy for some way. The coolies who had gone on with the breakfast things came upon seven wild yâks, who went off down the valley and were not seen again; they are, I believe, very wary; great numbers are to be seen here later in the season, when they are driven out of their higher haunts by snow into these lower grazing grounds, which were covered with their traces. They occupy this part of the country from about the end of October until March, the larger number roaming away into the high plains on the north, though some remain throughout the year in the neighbourhood of the Pangong, but I do not think are met with south of it. About half way down, the ravine narrows very considerably, and a mass of rock quite detached rises in the centre of the valley, a narrow gorge to the west being the direct road

to Kyam; by this the coolies proceeded, while I took the east side, crossing a low connecting ridge. Numbers of hares were seen, and I bagged a couple for the pot. I fell in near this, with a Mr. Turnor, a traveller from England; and when I told him the beat I was going, he said he would accompany me. He had been searching for the pass by which M. Schlagintweit had gone towards Ilchi; but by the natives with him (for he could not speak Hindustani) had been taken off in this direction, quite a contrary point of the compass. We marched on together, reaching at last the main stream of the Chang Chũngmo, called Kyamgo Traggar; this was broad, and a great thickness of alluvial deposits were exposed on its sides. It was an alluvial plain in its transition state before the river had cut its way down to the solid rocks. Its former levels were beautifully shewn in a series of steps and terraces, of which as many as five could be counted.

At the point where we descended from the alluvial terrace into the bed of the Kyamgo Traggar, there was a small rill of water, but this disappeared about half a mile on, where the valley narrowed considerably, and the hills rose on either hand in high cliffs of limestone, forming a regular gorge, through this the wind blew with great violence from the eastward, and dark angry clouds hid the mountain tops: it was evidently setting in for a stormy afternoon. We pushed on, struggling against the strong gusts of wind, and the gorge widening as we proceeded at last brought us to a broad valley spread over with detrital matter. The mountains still towered in cliffs to the south, but rose very gradually from about  $1\frac{1}{2}$  miles to the north, towards the high ridge of Samkang and Chamkang. It now began to snow hard, and we got under the lee of a low cliff, and sat there until our coolies came up, when we pitched the tents with great difficulty for the tent pegs would not hold in the gravelly bed of the stream; but by means of large boulder stones, this was accomplished. It was a miserable evening, snow falling until sunset, and lying on the top of the tents and in dry high spots. When the clouds broke at that hour, beautiful appeared the surrounding mountains with their white covering, the fleecy clouds, drifting up against the sides, added greatly to their height: the whole suffused with a lovely rose hue, and the sun shining upon the wet surface of the many tinted rocks, brought out their colours brighter than ever. Fires were soon blazing away, and we got ou

dinners as if nothing uncomfortable had happened. One must give the Indian cooks immense credit for the manner in which they work under the discomfort and difficulties that must from time to time happen on the march.

The valley ahead of us appeared to end at about six miles distance, and thus it had been sketched in on the rough reconnoissance I had, so the next morning it was determined to leave the camp where it stood, and go on ourselves to the main ridge of the valley, and return by evening. After breakfasting we walked up the soft gravelly bed of the river for about four miles, it then narrowed considerably, and took a bend to the east-south-east and at three miles further on divided into two large branches: we followed that having a nearly due east course. From the mountain spurs having approached so close to the broad bed of the Kyamgo Traggar, the absence of water, and it having also taken a bend, we had been led to imagine its course here ended, but this we were both of us much surprised to find was not the case, for we now beheld ahead of us an enormous broad gravel covered valley, stretching away to the foot of mountains at least 18 miles further to the eastward. It was quite impossible to reach the main ridge that day, so I sent a coolie back to bring on the tents. This open valley had the most peculiar aspect of any I had yet seen, but partook in its dry gravelly bed a good deal of the nature of those valleys I have seen between Pal and the Kiung Gang La; its elevation was about 16,400 feet, and its breadth in widest part about two miles; the ridge of hills, bounding it to the north, lay about four to five miles off, but were only 3,000 feet above it, and the spurs came with a very gradual fall towards the valley. On the south a very low ridge of about 500 feet, in places not more than 300, separated this valley plain from another broad one of a like character, the ravines of which ran up into the hills in wide beds, from 2 to 300 yards in breadth. Several broad lateral drainage plains also formed a junction with the one we were in from the northern line of hills that ran parallel with it. Directly ahead a low broad pass was visible, the mountains rising to the south of it in snowy peaks 21,000 feet high; but from the great altitude we stood at, and their distance 15 miles off, they gave no idea of so great an altitude. Plenty of the woody rooted wild lavender, or rather a stunted plant with the like scent, grew around, but grass was very scanty, only in two or



three spots was there found barely sufficient for the yâks ; a few large patches of snow still lay on the plain, these (for the hill sides were now quite bare of it) were the remains of deep drifts formed by the winter winds. Water was also very scarce, and we could obtain none that day until we reached the spot chosen for camp in the evening. The distances on this plain seemed interminable, the ends of low projecting spurs appeared in the clear atmosphere quite close at hand ; and had not the position of the pass ahead been fixed tolerably correctly on my plane table, we should, in all probability, have made our plans to reach it that evening ; and my fellow traveller would not believe that it lay so far to the east as it did. The "mirage" on the flat gravelly plain had at times the appearance of beautiful blue still lakes ; antelopes were very numerous ; and running across the plain in vicinity of this appearance, looked double their natural size. We found the sun very hot in the middle of the day ; but while waiting for our tents in the afternoon, found a blazing fire very comfortable ; and the night, with the usual great alternation of temperature, was very cold. We were on our way up the valley early on the 13th August, but did not reach the foot of the low hill until the afternoon. Antelope still very plentiful, and the males magnificent creatures, with beautiful long thin horns. The summit of the pass (17,960 feet) was quite 1,500 feet above the level of the valley at camp, but the ascent very gradual. The snowy mountains on the south could now be well seen, their valleys filled with ice, and from the pass in easterly direction lay another valley which also widened out into another of the same type as that we had marched up ; the hills seemed to fall on both sides, and the country generally to take a more open plateau like character. I could not spare time to proceed any further, I had much work to finish in the rear, and some high points to ascend, which the early snow-falls would shut up for the season. I much longed to explore, but could not do so. Mr. Turnor went on beyond for two days, and gave me afterwards a sketch of the ground. It appeared that some ten miles further, the open valley turned sharp south, and disclosed a long piece of water like the Pangong, but the mountains shut out the end of it, nor did he even get so far as the edge to tell me whether it was fresh or salt ; so that this may be, for all we know, another rival to the great Pangong Tso. Turnor saw six or seven miles of its waters, which he described as



having a breadth nearly equal to that of the above lake. I retraced my steps therefore down the valley finishing the sketch of it. Some fine agates and cornelian are to be found in a small ravine at the spot, where the long southern spur from Chamkang H. S. abuts on the Kyamgo Traggar. I made a short ascent here, in order to look over into the country to the south-east. This presented the appearance of large broad level valleys that might almost come under the designation of plains, the undulating ridges that divided them being of so little elevation. On the 15th August I had returned to the junction of the road from Pal, with that running down the valley towards the direction of Leh, and encamped close to the hot springs of Kyam. These rise at foot of the hills on the left bank; the alluvial plateau, on the edge of which they are situated, extends for about half a mile to the river, and ends in a low cliff. The water rises in several spots, covering a distance of about 150 yards long. The spring on the extreme west side is the largest, and temperature the highest: this I give below. The ground about is wet and swampy, and consequently beautifully green with grass and weeds; an incrustation of lime had formed about the springs, but very sparingly.

|                       |       |          |
|-----------------------|-------|----------|
| Western spring, ..... | 103.5 | degrees. |
| Centre, ... ..        | 102.0 | „        |
| Eastern, .....        | 98.0  | „        |

From the north-west a large tributary here joined the Chang Chùngmo river, adding so much to the depth of its waters, that it was a matter of difficulty crossing at the two fords below Kyam. The valley now lessened much in breadth, but the alluvial deposits were still well developed, and were cut into a series of steps by the gradual falling of the lake, or the diminished waters of the river on a drier climate commencing. At Pamzal the valley was still narrower, but these accumulations had disappeared. Here the Chang Chùngmo is left, and the road leads up the Rimdi Loomba to the Marsè Mik La, (18,452) and thence descends towards the Pangong basin, with a gradual fall down a broad valley passing Phobrang, Yùrgo, Tùblang to Lùkùng. At Chuggra, about three miles short of Phobrang, I turned to the north-west to the Kepting Kiptung La, 17,642. In the Gedmure Loomba was a green expanse of grass, with a rather severe ascent to a grazing spot called Boomzi, from this a high broad plateau

extended to the pass ; the line of watershed being so broad, that it was difficult to assign its exact position. This high wide valley parted north and south, in the first direction to the Ororotze La, 18,050 feet, only used by shepherds when taking flocks to graze in the lower courses of the Chang Chũngmo river.

The scenery here was grand and very striking from its novel nature. On the broad high plateau are three small lakes, from which flows away a stream bordered with bright green grass, running parallel to slopes of talus backed by mountains over 20,000, culminating in peak Shayok (No. 2) 21,000 feet. These mountains rise very abruptly and send down a row of glaciers that end in moraines upon the plain of the Koh Loomba. The sides of this mountain mass are rugged in the extreme, and topped with perpetual snow. Shayok (No. 2) throws down a mass of ice covered with moraine débris, which abuts upon the river itself. From the foot of this glacier, I hardly ever saw a grander sight than the steep falls of rock and ice of 3,500 feet in a horizontal distance of only three miles to the highest point. This portion of the Pangong mountains is well worth the visit of a traveller. At the time of my visit the increasing cold had driven the shepherds with their flocks and herds from the higher grounds, and we found some families at Montol, from which place there is a path over the mountains to Mũglib. I followed the Koh Loomba valley down towards the lake, where it ends in a narrow gorge opening out into a considerable broad expanse of open ground, on which are scattered some small hamlets containing only three or four families each, *viz.*, Phobrang, Yũrgo, Tũblang, and last of all, where the stream débouches into the plain of the Pangong itself, is Lookoong. Coming down the defile upon Yũrgo, is a very peculiar and striking peak overhanging the road. Its high rounded point is called by the natives "Chomo Kong Go," or the "Woman's Head," it having some resemblance to the shock head of a Tibetan belle.

Lookoong is situated about two miles from the spot where the waters of the Koh Loomba join the lake ; this distance is covered with sand, white and glaring to the eyes, and the sides of the ravine are cut down about 12 feet, forming a cliff of that height on either side. I did not see any fish here, the body of water in the stream, though much reduced from the quantity that rises at its sources,

is still very considerable, though not equal to that of the Chushal stream. I had now finished the whole of my work, and went on that day as far as Mûglib, thence to Tangsè, where I paid up my coolies and for yâks, &c. The men had behaved very well, never had I any occasion to be put out with them. From Tanksè I returned to the Indus valley over the mountains by way of the Kay La, 18,256 feet. The Kay Loomba river is fringed with grass and bushes for a considerable distance up, and at a height of 16,300 feet flows out of a lake about 400 to 500 yards long, of very deep clear water. It owes its origin to a large landslip from the left side of the ravine, by which cause a very considerable portion of the hill side has moved forward and been disrupted. The rock is granitoid, the same as the Chang La, and forms the main axis of this mountain chain between the Indus and Shayok. From the lake to the pass, the scenery was wild as wild could be; near its source the ravine turned south and was nearly level for some distance, finally ending amid a mass of scattered rocks, débris, and snow; large beds of which still filled the ravines and lay in patches on the summit of the ridge. The wind blew with great violence from the west-south-west on reaching the pass, with that cutting, piercing, unsparring manner it does at these elevations; behind the shelter of some rocks I boiled the thermometers, and then descended into the valley below. All my followers now on the return journey walked their best; and by the evening we were well into the cultivation of the valley above Chimray. The next day I reached Leh, and was glad to meet some brother Surveyors, also on their return from their respective surveys.

In the foregoing pages, reference has often been made to the great accumulations of boulders, gravels more or less angular, clays and sands, near Tanksè and in the Chang Chûngmo; it is necessary to add a few words in conclusion regarding the cause I assign for their formation. This is, I think, clearly glacial. Proofs are not wanting that, in ages past, the valleys of the Himalaya contained glaciers of enormous length and thickness, the only prototypes of which are to be seen in those now filling the valleys of the Karakoram, far north in Baltistan. About half way between the villages of Kungun and

Gond lying on the Sind river a tributary of the Jhelum, Kashmir, and at the village of Gond itself, marks of glacial action are unmistakeable in the deep grooves or striæ-marks cut in the hard metamorphic slates, at a height of about 150 or 200 feet above the present level of the river. This point is 20 miles in a direct line from the head of the valley, where at present some very small glaciers exist. How much further this glacier extended towards the plain of the Kashmir valley, it is impossible to say; but at the débouchement 10 miles below, thick beds of débris are to be seen; the Sind river is still of very considerable size, and glacial accumulations are very soon swept away, as may be seen in now existing large glaciers below their terminal cliffs.

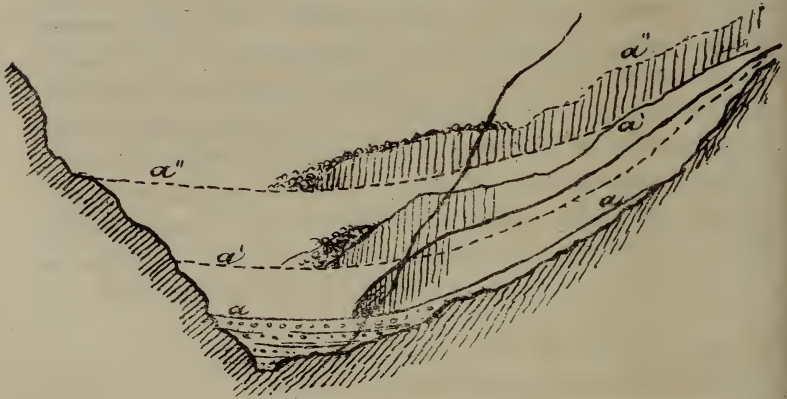
Taking 5,500 feet as the lowest limit of its extension, every valley in the vicinity of a range equal in mean altitude to the mountains north of Kashmir, must have once been the bed of these moving rivers of ice. The indications of glacier extension are also seen on the north of the Zogi La, between the present glacier of Muchoi and Pundras, at 10 miles from the pass. It is my belief that the Dras plain was once buried in ice, and that this region presented much the same appearance that the neighbourhood of the Mustakh does now. The imagination can hardly conceive the enormous magnitude that glaciers, like those in the Karakoram, must have once attained;\* and that they extended into the Skardo valley on the Indus, 70 to 80 miles, is by no means improbable. Smaller ones from the ridge to the south we know did, for near Kepchùn, a fine mass of moraine protrudes into the plain nearly a quarter of a mile, having very large angular blocks on its surface. Moreover, this moraine must have been formed after the valley around Skardo had assumed somewhat its present configuration, for this basin has at some period been filled up with beds of lacustrine deposit, gravels, and conglomerates, to a height that overtops the present isolated rock rising above the town, the coarser beds being the highest in the series; but it is quite natural to suppose that, on a milder climate succeeding, these larger alluvial deposits would be the first to be removed by the extinction of glaciers further down the valley,

\* The existing glacier of Baltoro is 36 miles long in direct horizontal distance.



while the cold was yet intense enough to preserve those around and above Skardo. Though the vast accumulations of detritus in the Skardo basin were, I conceive, due to the glaciers from the high ranges, both to the north and south of the Indus near Basha,—which glaciers must have extended close down to and dammed up the river,—it does not follow as some might be led to suppose that the whole mass of such a mighty barrier should be formed of ice. It was the débris of moraines that would have composed this, from its continued accumulation in so narrow a gorge as the Indus there presents. These exuvia there piled up, would have raised the bed of the gorge, and the bed of the lateral valley as well, also elevating the active cause, *viz.*, the glacier itself; and in course of time the whole valley level would have been brought up to the height of the great deposits around Skardo. The section below (Fig. 6.) will, I hope, explain my meaning, in which *a*, *a'*, *a''* represent the successive levels of the gorge and corresponding lateral glaciers.

Fig. 6.



Innumerable other instances can be seen of ice action throughout the Kashmir territory; I will instance near the Fotu La, on the road to Leh, a spot now far removed from such causes in action. Even in the valley of the Jhelum, below Bara Múla, the effects of a glacial period can be seen. That glaciers filling lateral ravines have extended across the main valleys at some periods of their existence is most

89°

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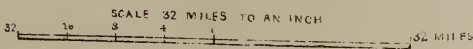
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PART OF THE  
**BHOOTAN DOORS.**

REFERENCES

- Clay and Conglomerates.
- Tertiary Sandstones
- Limestone Nummulitic
- Schists
- Gneiss



probable; and in nearly every case where gravel deposits are seen, some side ravine below, having its sources high up, can be pointed out, whose glacier has formed a temporary stoppage to the main river into which it ran: and such effects are still in progress in the highest ranges of the mighty Himalayas. When glaciers extended down to 5,000 feet, what must have been the appearance of the upper Shayok, Indus and Chang Chùngmo, where 12 to 13,000 is the lowest level of the country; contemplation of such a scene in the mind's eye renders the formation of lakes and the accumulations of detrital matter a natural sequence very easy to imagine. Further, when such powerful forces of ice and water were in action, their results would have extended far down the main drainage lines, and are to be sought for at the débouchements of such rivers as the Indus, the Sutlej, Ganges, &c.; and I believe that the more recent accumulations of immense boulder beds composed of rocks from the inner ranges, such as may be seen in the Noon Nuddee, Deyrah Dhoon, and other places along the base of the Himalayas, may owe their existence to a glacial period in those mountains.

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Notes on Geological features of the country near foot of hills in the Western Bhootan Dooars.—By Captain H. H. GODWIN-AUSTEN, F. R. G. S., Topographical Survey.

[Received, 26th March, 1867.]

In the report 'On the coal of Assam, with Geological notes on the adjoining districts to the south,' &c. by H. B. Medlicott, Esq., Deputy Superintendent of the Geological Survey, published in the Memoirs of that Survey,* allusion has been made to certain geological features of the hills bounding the Western Bhootan Dooars.†

A few more explanatory notes on the formations to be seen there may prove of interest in connection with the above paper, and lead others who may have the opportunity to observe them more closely. The base of the Himalayas is there so densely wooded that much

* Mem. Geol. Survey of India, Vol. IV. p. 387. See pages 392 and 435, 436.

† See the map of "Bhootan and country adjacent" on the scale of 4 miles to the inch for all places mentioned in this paper.